

RABIN & CHAMPAGNE, P.C.

STEVEN M. RABIN
 THOMAS M. CHAMPAGNE*
 ROBERT H. BERDO, JR.
 GEORGE F. WALLACE*
 QIXIA ZHANG, Pat. Agent (China)

SUITE 500
 1101 14th STREET, N.W.
 WASHINGTON, D.C. 20005

PATENT, TRADEMARK
 AND COPYRIGHT LAW
 TELEPHONE: (202) 659-1915
 TELEFAX: (202) 659-1898
 E-MAIL: steven@rabinchamp.com
firm@rabinchamp.com


*ADMITTED TO A BAR OTHER THAN D C

June 15, 2001

In Affiliation with
 PAUL W. KODA

| | | |
|---|--|---|
| FORM PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE | | ATTORNEY'S DOCKET NUMBER |
| TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371 | | GOT 142 NP |
| | | U.S. APPLICATION NO. To Be Assigned 097868233 |
| INTERNATIONAL APPLICATION NO. PCT/JP99/01494 | INTERNATIONAL FILING DATE 24 MARCH 1999 (24.03.99) | PRIORITY DATE CLAIMED 18 DECEMBER 1998 (18.12.98) |
| TITLE OF INVENTION HYBRID DRIVE DEVICE | | |
| APPLICANT(S) FOR DO/EO/US Jun YAMADA, Yoshiaki YAMADA, Yoshito WATANABE and Masakazu SASAKI | | |
| Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information: | | |
| <ol style="list-style-type: none"> 1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1). 4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date. 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)). <ol style="list-style-type: none"> a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau (Form PCT/IB/308 enclosed). c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)). 7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)). <ol style="list-style-type: none"> a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau). b. <input type="checkbox"/> have been transmitted by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input checked="" type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). 10. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)). | | |
| Items 11. To 16. below concern document(s) or information included: | | |
| <ol style="list-style-type: none"> 11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 13. <input type="checkbox"/> A FIRST preliminary amendment. A SECOND or SUBSEQUENT preliminary amendment. 14. <input type="checkbox"/> A substitute specification. 15. <input type="checkbox"/> A change of power of attorney and/or address letter. 16. <input checked="" type="checkbox"/> Other items or information: - 1 sheet of Drawings (Figs. 1 - 2) | | |

JC18 Rec'd PCT/PTO 1 5 JUN 2001

| | | | | | |
|--|--------------|---|------------|--|-----------|
| U.S. APPLICATION NO. To Be Assigned 087868233 | | INTERNATIONAL APPLICATION NO. PCT/JP99/01494 | | ATTORNEY'S DOCKET NUMBER GOT 142 NP | |
| 17. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492(a)(1) - (5)): Search Report has been prepared by the EPO or JPO \$860.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) \$690.00 No International preliminary examination fee paid to USPTO (37 CFR 1.482) But international search fee paid to USPTO (37 CFR 1.455(a)(2)) \$710.00 Neither international preliminary examination fee (37 CFR 1.482) nor International search fee (37 CFR 1.455(a)(2)) paid to USPTO \$1000.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2) - (4) \$100.00 | | | | CALCULATIONS PTO USE ONLY | |
| ENTER APPROPRIATE BASIC FEE AMOUNT = | | | | \$ 860.00 | |
| Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)) | | | | \$ 130.00 | |
| CLAIMS | NUMBER FILED | NUMBER EXTRA | RATE | | |
| Total claims | 4 - 20 = | 0 | x \$18.00 | \$ 000.00 | |
| Independent claims | 2 - 3 = | 0 | x \$80.00 | \$ 000.00 | |
| MULTIPLE DEPENDENT CLAIM(S) (IF APPLICABLE) | | | + \$260.00 | \$ 000.00 | |
| TOTAL OF ABOVE CALCULATIONS = | | | | \$ 990.00 | |
| Reduction of 1/2 for filing by small entity, if applicable. Small Entity Status is Asserted. | | | | \$ | |
| SUBTOTAL = | | | | \$ 000.00 | |
| Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)) | | | | + | \$ 000.00 |
| TOTAL NATIONAL FEE = | | | | \$ 990.00 | |
| Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property + | | | | \$ 0.00 | |
| TOTAL FEES ENCLOSED = | | | | \$ 990.00 | |
| | | | | Amount to be Refunded: | \$ |
| | | | | Charged: | |
| <p>A check in the amount of <u>\$990.00</u> to cover the above fee is enclosed.</p> <p>The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 18-0002. A duplicate copy of this sheet is enclosed.</p> <p>NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</p> <p>SEND ALL CORRESPONDENCE TO:</p> <p style="text-align: center;">RABIN & CHAMPAGNE, P.C. CUSTOMER NO. 23995 Telephone - (202) 659-1915 Facsimile - (202) 659-1898</p> <p style="text-align: right;">  SIGNATURE NAME: Steven M. Rabin REG. NO.: 29,102 </p> <p>Date: <u>June 15, 2001</u></p> | | | | | |

1/PRTS

09/868233

IG18 Rec'd PCT/PTO 1 5 JUN 2001

- 1 -

SPECIFICATION

TITLE OF THE INVENTION

HYBRID DRIVE DEVICE

FIELD OF THE INVENTION

This invention relates to a hybrid drive device combining an engine and an electrical motor as the prime mover for a vehicle.

BACKGROUND OF THE INVENTION

A hybrid drive device is known in which an electrical motor is driven to operate a vehicle with the electrical power generated by a generator which is driven by an engine. A hybrid vehicle improves exhaust emission performance and vehicle fuel economy by use of this type of drive device.

Many such hybrid drive devices use a secondary battery as a storage device charged by the excess electrical power of the generator. However since a secondary battery displays poor charging/discharging characteristics, desired fuel economy performance resulting from the regeneration of braking energy is not realized. Regeneration of braking energy is controlled to effectively utilize energy generated by the electrical motor using vehicle inertia during braking. Thus efficient storage of generated power is important. On the other hand, the secondary battery must be replaced at fixed intervals generally since the component life of the battery is short. This in turn increases the component running costs.

Tokkai-Hei 6-209501 published by the Japanese Patent Office in 1994 discloses a hybrid drive device in which a condenser used as a storage device to drive a motor. However a storage device with the required capacity to drive the vehicle has a weight or a volume which exceeds the limited storage space available in the vehicle. This is due to the fact that the condenser has a low energy density.

09868233-0001

The present invention has the object of providing a hybrid drive device which efficiently uses the electrical power generated by a generator. A further object of the present invention is to provide a hybrid drive device having low running costs. Yet a further object of the present invention is to provide a hybrid drive device which facilitates storage of components in the limited space available in a vehicle.

A hybrid drive device according to the present invention comprises a generator which is driven by an engine, a storage device which stores generated electrical power from the generator, and an electrical motor which is driven by the electrical power of the storage device and/or the electrical power of the generator. The invention is characterized in that the storage device is provided with a bank of condensers formed by the connection of a plurality of condenser cells in series, and that a parallel monitor is connected in parallel to each condenser cell, the parallel monitor bypassing a charging current when the respective terminal voltages exceed a fixed value.

In this manner, even when the size of the electrostatic capacity or the leakage current of each condenser cell displays large variations, it is possible to charge or discharge each condenser cell equally. In the arrangement provided with a parallel monitor, since it is not necessary to provide for a leeway with respect to a dielectric voltage in consideration of the voltage variation between condenser cells, several tens of percent downsizing of condenser in terms of electrostatic capacity is possible, in comparison with an arrangement not provided with a parallel monitor. Although the dielectric voltage per cell in the condenser is small, the voltage value is increased to a required level by connecting a plurality of such cells in series.

According to the present invention, the storage device is provided with switching converter. The switching converter has fixed current output characteristics and controls a charging current to the condenser bank. Generally a condenser is charged by a fixed voltage power source with half the charging power being lost as heat which results from resistance between the power source and the condensers. In contrast, according to the present invention, the switching converter controls the charging power to the condensers with a fixed current

Since the condenser is not a fixed voltage device and its state of charge (SOC) is obtained accurately from its voltage, it is possible to perform effective control of the generator based on the state of charge. Furthermore since the charge/discharge cycle life of a condenser is long, component replacement is not required for long periods of time. That is to say, running costs are considerably lower than those associated with a secondary battery.

The controller controls the switching converter so that a motor output is obtained which corresponds to the required drive force. Furthermore the controller controls the engine, that is to say, the generated amount of the generator so that the state of charge is maintained to a suitable value. In this manner, it is possible to maintain a suitable state of charge under normal conditions although the drive device always outputs a drive force which is required by the vehicle.

Furthermore the switching converter displays fixed voltage output characteristics having a wide operating range corresponding to condenser characteristics in which the terminal voltage is reduced to zero as a result of power discharge. This allows more efficient use of stored electrical power. Since the electrical power of the condenser is

proportional to the square of the terminal voltage, for example if the switching converter functions up to $1/2$ of the rated output voltage, up to 75% of the stored power can be used. Otherwise if the switching converter functions up to $1/4$ of the rated output voltage, up to 94% of the stored power can be used. Thus it is possible to obtain a high power utilization efficiency even when performing discharge of large current during acceleration or the like by controlling the operation of the switching converter in response to drive power requirements of the vehicle.

Furthermore mounting of the hybrid drive device in a vehicle is facilitated since the weight and the volume of the storage device are reduced by adapting an electrical double-layer condenser which has a large electrostatic capacity as a condenser cell.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram of an embodiment of the present invention applied to a hybrid vehicle.

Fig. 2 is a schematic diagram of an embodiment of the storage device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a schematic diagram of an embodiment of the present invention applied to a hybrid vehicle. As shown in the figure, a drive shaft of the generator 14 is connected to the output shaft of the engine 13 used for power generation. An alternating current generated by the generator 14 is converted to a direct current by a converter 15 and output as a charging current to the storage device 12 which is described below. Alternatively the current is output as a drive current to the electrical motor 10.

A differential gear 19 is provided between left and right axle shafts 18-18 which are mounted on respective drive wheels 9. The output shafts of a gearbox 16 and a propeller shaft 17 are connected to the input shaft of a differential gear 19. The input shaft of the gear box 16 is connected to a drive shaft of the electrical motor 10. The gear box

16 reduces the rotation speed of the electrical motor 10 to a fixed gear ratio, and transmits these rotations to the propeller shaft 17. The electrical motor 10 is driven by an AC current from an inverter 11. The output of the electrical motor 10 is transmitted to the drive wheels 9 via the gearbox 16, the propeller shaft 17, the differential gear 19 and the axle shafts 18.

The storage device 12 comprises a condenser bank 20 formed by connecting a plurality of condenser cells 21 in series to as shown in Fig. 2, parallel monitors 22 which are respectively added to each condenser cell 21, and a bi-directional switching converter 23 which controls charging/discharging of the condenser bank 20.

The parallel monitor 22 is a circuit which monitors the terminal voltage of the condenser 21 and in which a current flows so that the condenser 21 is bypassed when a condenser terminal voltage exceeds a fixed value. The parallel monitor 22 is attached to each condenser cell 21. The parallel monitor 22 and the condenser cell 21 are connected in parallel.

The switching converter 23 has fixed current output characteristics when controlling the charging current to the condenser bank 20 and fixed voltage output characteristics in a wide operating range when controlling the discharge current from the condenser bank 20. The switching converter 23 controls the discharge current with a controller 24 in response to the drive force required by the vehicle. The required drive force is represented by the depression amount of the accelerator pedal for example.

An electrical double-layer condenser with a large electrostatic capacity is used as the condenser cell 21. Although one condenser cell has a small dielectric voltage, the required dielectric voltage is obtained by connecting a plurality of such cells in series. Many condenser cells 21 may be connected in series-parallel as a condenser bank 20.

The controller 24 controls the regeneration of braking energy and the drive force of the vehicle. The state of charge (SOC) of the storage device 12, the braking state, and the depression amount of the accelerator pedal of the vehicle are input as required detection signals for the controller 24 to perform various types of control.

This type of structure allows the storage device 12 to be charged with electrical power generated by the electrical motor 10 during

006623 08E07
T00280 0028800

regeneration of braking energy or with excess electrical power of the generator 14. The stored electrical power is supplied to the electrical motor 10 when a large amount of power is required during vehicle acceleration or the like. The condenser 21 reduces the terminal voltage towards a value of zero as power is discharged. However the switching converter 23 which has a wide operating range controls the discharged power with fixed voltage output characteristics. As a result, it is possible to use the stored power of each condenser 21 with high efficiency.

For example, if the switching converter 23 functions up to 1/2 of the rated output voltage, up to 75% of the stored power can be used. Otherwise if the switching converter 23 functions up to 1/4 of the rated output voltage, up to 94% of the stored power can be used. Thus it is possible to obtain a high power utilization efficiency even when performing discharge of a large current such as during acceleration or the like by controlling the operation of the switching converter 23 in response to the drive power requirements of the vehicle.

The stored power E_c of the condenser 21 is expressed by the following Equation (1):

$$E_c = 1/2 CV^2 \quad (1)$$

, where C is electrostatic capacity and V is voltage.

When the condenser is charged by a fixed voltage power source, the power E_p is expressed by the following Equation (2):

$$E_p = QV = CV^2 \quad (2)$$

, where Q is the electrical charge.

The ratio E_c/E_p of the charging power E_p and the stored power E_c , that is to say, the charging ratio is 50% from Equations (1) and (2). Since the condenser is not a fixed voltage device such as a secondary battery, when charged by a fixed voltage, half the charging current is lost as heat due to resistance components between the condenser and the battery. In contrast, the switching condenser 23 in the present embodiment controls the charging current to the condenser 21 to a fixed current output. As a result, even when charging is performed

It is desirable for the hybrid vehicle drive device to perform control operations on the charging/discharging amount of the storage device 12 so that the state of charge SOC is normally in a suitable range. Although a lithium-type battery allows relatively accurate determination of the state of charge SOC on the basis of the battery voltage, in general many types of secondary batteries do not allow highly accurate

[illegible]

Since the cycle life concerning the charging/discharging of the condenser 21 is longer than a general vehicle cycle life, it is almost never necessary to replace the condenser 21 during the life of the vehicle. That is to say, the condenser 21 entails much lower running costs for the drive device in comparison to a secondary battery. When the input voltage range of the inverter 11 is wide, it is possible to use a switching converter without fixed voltage output characteristics with respect to charging.

1. A hybrid drive device having a generator which is driven by an engine, a storage device which stores generated electrical power from the generator, and an electrical motor which is driven by the electrical power of the storage device and/or the electrical power of the generator;

a condenser bank having a plurality of condenser cells connected in series;

a switching converter with fixed current output characteristics which controls the charging electrical power to the condenser bank.

the hybrid drive device comprising:

a parallel monitor which is connected in parallel to each condenser cell and which bypasses the charging current when the respective terminal voltages exceed a fixed value;

a controller which detects the amount of the state of charge in the storage device and the required vehicle drive power and controls the switching converter to achieve a motor power corresponding to the required drive power, the controller controlling the engine to maintain the amount of the state of charge to a suitable value.

3. The hybrid drive device according to Claim 1 or Claim 2, wherein the switching converter of the storage device further has fixed voltage output characteristics and a wide operating range, and further controls

[illegible]

- [illegible]

In a hybrid drive device which drives an electrical motor with an electrical power of a storage device and/or the electrical power of a generator driven by the engine, in general a secondary battery is used as a storage device. However running costs of the drive device are elevated due to the necessity to replace the storage device at fixed intervals due to a short battery component life. In addition, the low charging/discharging efficiency of a secondary battery limits improvements in fuel economy of the drive device.

The present invention provides a storage device comprising a condenser bank with a plurality of condenser cells connected in series, a parallel monitor which is connected in parallel to each condenser cell and which bypasses the charging current when the respective terminal voltages exceed a fixed value, and a switching converter with fixed current output characteristics which controls the charging electrical power to the condenser bank. This arrangement allows the present invention to realize improvements in fuel economy and reductions in running costs in a hybrid drive device.

FIG. 1

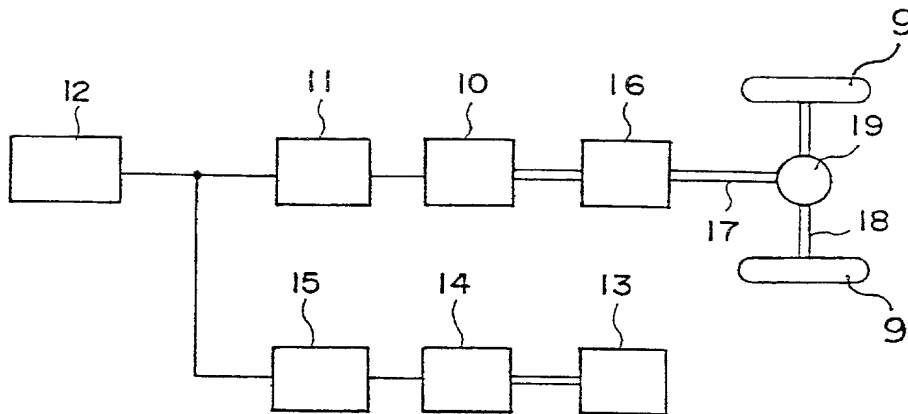
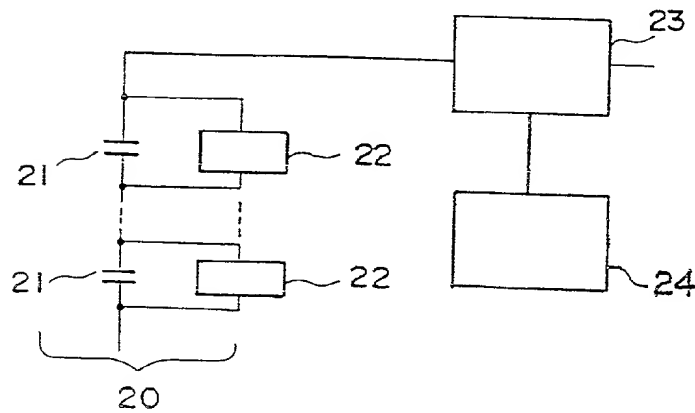


FIG. 2



**DECLARATION FOR UNITED STATES PATENT APPLICATION,
POWER OF ATTORNEY, DESIGNATION OF CORRESPONDENCE ADDRESS**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

HYBRID DRIVE DEVICE

the specification of which

☒ is attached hereto.

☐ was filed on _____, as Application Serial No. _____,
and was amended on _____ [if applicable].

☒ was filed under the Patent Cooperation Treaty on March 24, 1999
Serial No. JP99/01494, the United States of America being designated.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose to the Patent and Trademark Office information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

| Prior Foreign Application(s) Number | Country | Date Filed | Priority Claimed Yes No |
|--|---------|-------------------|----------------------------|
| 10-360483 | JAPAN | December 18, 1998 | yes |

I hereby appoint the following attorneys to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith: Steven M. Rabin (Reg. No. 29,102), Thomas M. Champagne (Reg. No. 36,478), Robert H. Berdo, Jr. (Reg. No. 38,075), and David S. Lee (Reg. No. 38,222), 1101 14th Street, N.W., Washington, D.C. 20005, Telephone: (202) 659-1915; Fax: (202) 659-1898. Address all correspondence to RABIN & CHAMPAGNE, P.C., 1101 14th Street, N.W., Suite 500, Washington, D.C. 20005.

The undersigned hereby authorizes the U.S. attorneys named herein to accept and follow instructions from the undersigned's assignee, if any, and/or, if the undersigned is not a resident of the United States, the undersigned's domestic attorney, patent attorney, patent agent, or patent representative as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signature: YAMADA, Jun Date: August 02 20 01
First Joint Inventor: YAMADA, Jun
Citizenship: JAPAN
Residence and Post Office Address: 1, Ooaza 1-chome, Ageo-shi, Saitama 362-8523, JAPAN JPX

Signature: YAMADA, Yoshiaki Date: August 02 20 01
Second Joint Inventor: YAMADA, Yoshiaki
Citizenship: JAPAN
Residence and Post Office Address: 1, Ooaza 1-chome, Ageo-shi, Saitama 362-8523, JAPAN JPX

Signature: WATANABE, Yoshito Date: August 02 20 01
Third Joint Inventor: WATANABE, Yoshito
Citizenship: JAPAN
Residence and Post Office Address: 1, Ooaza 1-chome, Ageo-shi, Saitama 362-8523, JAPAN JPX

Signature: SASAKI, Masakazu Date: August 02 20 01
Fourth Joint Inventor: SASAKI, Masakazu
Citizenship: JAPAN
Residence and Post Office Address: 1, Ooaza 1-chome, Ageo-shi, Saitama 362-8523, JAPAN JPX